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LACANOBIA SUBJUNCTA (LEPIDOPTERA: NOCTUIDAE) ON TREE FRUITS IN THE PACIFIC NORTHWEST

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Abstract.—Larvae of the noctuid moth *Lacanobia subjuncta* (Grote & Robinson) were collected on commercial apple trees, as well as pear and plum trees, in central Washington and north central Oregon, during June to September 1996. Larvae were reared to adult on foliage of the tree species on which they were collected. Adult moths were captured in molasses-baited traps placed in apple orchards, primarily from mid May to early June and again in August 1996 near Yakima, Washington. In the laboratory, *L. subjuncta* were successfully reared from egg to adult on several herbaceous weed species common in local tree fruit orchards. Multiple generations were successfully reared from egg to adult on apple seedlings grown in a greenhouse.

Key Words.—Insecta, cutworm, apple, host plant, rearing.

Fruitworms and cutworms in the family Noctuidae are occasional and minor pests of tree fruits. Howell (1993) reviewed the biology of several species of Noctuidae occurring on foliage and fruit of tree fruits in the Pacific Northwest (PNW), referring primarily to apple and pear. Three noctuid species were reported to use tree fruits as primary hosts and are occasional pests in organic orchards or on backyard trees (Howell 1993). These are the green fruitworm *Lithophane antennata* (Walker), the speckled green fruitworm *Orthosia hibisci* Guenee, and the pyramidal fruitworm *Amphipyra pyramidoides* Guenee.

All three species of fruitworm are widespread throughout much of temperate North America (Covell 1984, Crumb 1956), but their pest status in the PNW is unknown. Recently, damage to apple fruit in Washington has been linked to cutworms without identification of the species causing the problem (Warner 1996, Landolt 1997). It is not clear what species of Noctuidae may be causing damage to apple in the PNW because published accounts of collections and identifications of noctuid larvae from tree fruits are generally lacking.

The objective of this study was to verify the species of noctuids on apple in central Washington that may be contributing to crop losses, particularly in organic orchards and orchards using mating disruption to control codling moth, *Cydia pomonella* L. Reported here is the identification of a single species, *Lacanobia subjuncta* Grote & Robinson, from larvae collected and reared from apple, pear, and plum from multiple localities in Washington and Oregon. Additionally, the pattern of adult *L. subjuncta* activity through the season (indicating the number of generations per year) and successful larval development on five species of herbaceous plants common in orchards are reported.

MATERIALS AND METHODS

In order to obtain identifiable adult specimens, all noctuid larvae collected from fruit trees during 1996 were reared in the laboratory on foliage of the tree species on which they were collected. Collections were largely from three sources: 1) weekly systematic sampling for spiders (from beating tray samples) in three apple

orchards (June through mid-October), 2) nonsystematic sampling for larval leafrollers (Torticidae) in apple, pear and plum orchards, and 3) from pest control advisors sampling in response to visible damage to foliage and fruit. Larvae were placed in glass jars with field-collected foliage of the host species on which they were collected. Foliage was added or exchanged as needed and 3 cm of damp soil was placed in the bottom of jars as a pupation medium. Emerged moths were pinned and spread as voucher specimens which are deposited in the collection of the author, in the M. T. James Entomological Collection, Washington State University, Pullman, WA, and in the W. F. Barr Entomological Collection at the University of Idaho, Moscow, ID.

Lacanobia subjuncta were reared in the laboratory for one generation on apple sucker growth cut in commercial apple orchards, and then for multiple generations on apple seedlings grown in a greenhouse. Eggs for this colony were obtained from females that were captured in a light trap placed in an apple orchard during August 1996. About 60 females were placed individually in 20 ml polystyrene snap cap vials. Eighteen of these females laid eggs. Vials containing eggs were held in an environmentally controlled room (22° C, 70% RH) until eggs hatched and neonate larvae were moved with a fine camel hair brush to ten, 4-liter glass jars containing apple foliage. Fifty larvae were placed in each jar. Foliage was added or exchanged as needed and 3 cm of damp soil was added when larvae were mature, as a pupation medium. About 250 pupae were removed from the soil, sorted by sex, and placed into paper cups in screened cages for adult emergence.

Subsequent generations were reared in the laboratory on potted apple seedlings grown in a greenhouse. Eggs were obtained from lab-reared moths placed in 10 × 15 × 20 cm plastic boxes with screened lids. Each box contained water and sugar-water on cotton balls in plastic petri dishes (4 cm diam) and one or two pairs of adult moths. Eggs or hatching larvae were transferred to 45 × 45 × 45 cm screened cages containing potted apple seedlings (40–60 cm tall). Seedlings were added as needed, and 3–5 cm of damp vermiculite was placed in the bottom of cages as a pupation medium. One hundred to 200 larvae were placed in each cage. Pupae were removed from vermiculite and potting soil, sorted by sex, and placed into paper cups in screened cages for adult emergence. This colony was used to provide larvae for assessments of host plant suitability.

The seasonal pattern of *L. subjuncta* moth activity was documented in two field tests of moth attraction to food baits. Both trapping experiments were part of a study of codling moth attraction to sweet baits. Traps for both tests were set up in early May and were maintained until the third week of September, 1996. Traps were checked, and moths removed, on most days and bait was replaced every two weeks. In test A, eight traps were baited with 10% aqueous solutions of molasses (Grandma's Molasses, unsulphured, Motts; USA, Stamford, CT) and eight traps were baited with aqueous solutions of jaggery, a palm sugar extract (Indian Kolhapur Jaggery, House of Spices Inc., Jackson Heights, N.Y.) (Landolt 1995). All 16 traps were glass McPhail traps (Newell 1936) containing 200 ml of bait. The test was conducted within a Golden Delicious apple orchard near Parker, Yakima County, Washington. Traps were placed at a height of 2 m and 30 m apart. Data were transformed (square root [x + ½]) and subjected to ANOVA, and treatment means were compared by F test (SAS Institute 1985) to determine if captures of

Table 1. Collections of noctuid larvae in 1996 from commercial tree fruit orchards. Larvae reared to adult stage in laboratory for identification.

Date	Locale	Number	Host
VI-1-1996	OR, Umatilla Co., Milton-Freewater	2	Apple
VII-1996	WA, Grant Co., Mattawa	2	Apple, Golden
VII-3-1996	OR, Umatilla Co., Milton-Freewater	1	Apple
VII-11-1996	WA, Mattawa	1	Apple, Fuji
VII-24-1996	WA, Yakima Co., Parker	4	Pear, Bartlett
VII-29-1996	WA, Yakima Co., Yakima	1	Apple
VIII-1996	OR, Umatilla Co., Milton-Freewater	2	Apple
VIII-29-1996	WA, Yakima Co., Parker	12	Plum
IX-6-1996	WA, Benton Co., Prosser	6	Apple
IX-12-1996	WA, Benton Co., Prosser	14	Apple
IX-12-1996	WA, Yakima Co., Parker	3	Apple
IX-23-1996	WA, Yakima Co., Parker	1	Apple
IX-30-1996	OR, Umatilla Co., Milton-Freewater	1	Apple, Red Delicious
X-1-1996	WA, Yakima Co., Parker	1	Apple, Red Delicious
X-7-1996	WA, Yakima Co., Parker	1	Apple
X-8-1996	WA, Yakima Co., Parker	1	Apple

L. subjuncta moths with bait types were not equal. In test B, 4 trap designs were compared, with all traps were baited with 200 ml of 10% molasses. Trap types were glass McPhail traps, Multipher traps (BioControl Services Inc.), Trappit Dome Trap (Agrisense, Palo Alto, CA), and open bowl traps (white plastic disposable cereal bowls suspended by a wire hanger). Six replicates of these 4 trap designs were maintained through the field season. This experiment was established in one orchard, but was moved to a second orchard on July 6. Both orchards were Golden Delicious apple plantings. Data were transformed (square root [x + ½]) and subjected to ANOVA. Significant differences between treatments were determined using Tukey's Studentized Range Test (SAS Institute 1985).

Host suitability data was obtained for *L. subjuncta* larvae on foliage of black medic (*Medicago lupina* L.), dandelion (*Taraxacum officinale* Weber), sow thistle (*Sonchus oleraceus* L), bindweed (*Convolvulus arvensis* L.), redroot pigweed (*Amaranthus retroflexus* L.), mallow (*Malva neglecta* Wallr), and lambsquarters (*Chenopodium berlandieri* Moq.). Five newly hatched larvae were placed into 100 ml wax coated paper cups containing plant foliage as an assay unit. Foliage was added or replaced as needed until larvae were dead or neared maturity. Three cm of damp vermiculite was then added as a pupation medium. Pupae were removed, sorted by sex, and placed in 500 ml clear plastic cups until adult eclosion. This assay was conducted using five cups for each host plant species or tree fruit variety. Data were recorded for evidence of feeding, pupation and adult emergence, date of adult emergence, and sex of adults.

Results

Sixteen samples of noctuid larvae were collected from 6 localities in Washington (the Parker area SE of Yakima, west Yakima, Moxee, Zillah, Mattawa, and Prosser) and near Milton-Freewater, Oregon (Table 1). Although most samples were taken from commercial apple orchards, one was from a commercial pear orchard and one from a commercial plum orchard. Fifty-three larvae were reared

to adult and were determined to be *L. subjuncta*. Two additional specimens taken in an apple orchard near Prosser, WA on 12 Sep 1996, were parasitized by an ichneumonid wasp but are considered to have been *L. subjuncta* based on coloration and pattern. There were no other species of Noctuidae in these samples.

One thousand nine hundred and ninety-eight *L. subjuncta* moths were captured in traps baited with sweet baits from May through mid September 1996 (Fig. 1). Two distinct peaks of moth catches were evident in both plots, from mid May through mid June, and again in August into early September. Very few moths were captured during July. The sex ratio of moths captured in traps baited with sweet baits was 2:3 females to males. In both plots, numbers of moths captured during the first flight period were higher than in the second (Fig. 1). Numbers of *L. subjuncta* males and females captured in traps baited with molasses (2.8 ± 0.5 females, 2.6 ± 0.5 males) and traps baited with jaggery (2.4 ± 0.6 females, 1.5 ± 0.4 males) were not significantly different ($F = 3.78$, $P > 0.05$). In the comparison of trap types, captures of *L. subjuncta* moths were significantly reduced in bowl traps (5.05 ± 1.2) compared to McPhail (11.81 ± 2.0), Multipher (8.1 ± 1.4), or Dome traps (8.9 ± 1.4) ($P < 0.05$, df = 204, $n = 52$). There were no significant differences among mean numbers of moths captured in McPhail, Multipher, and Dome traps baited with molasses solution.

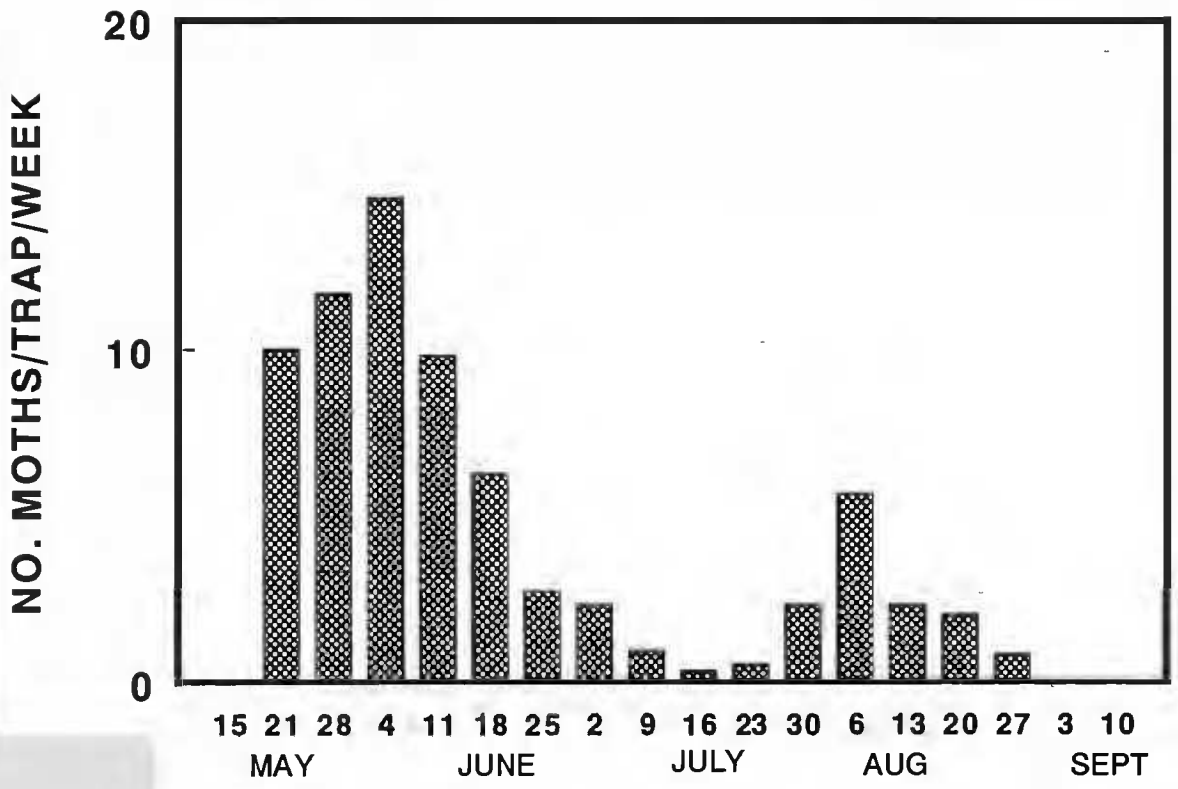
The percentages of *L. subjuncta* that survived and developed on plants tested was low (Table 2), but successful development to the adult stage did occur on dandelion, sow thistle, bindweed, and mallow, indicating that these plants are potential hosts. Larvae fed on all species of plants tested, as evidenced by the presence of frass and larval growth.

Discussion

Lacanobia subjuncta is common and widespread in apple growing areas of central Washington and the contiguous areas of Oregon. Large numbers of adults were collected in traps with sweet baits from mid May through much of September. One hundred and fifty-six moths were captured in one night with a light trap in an apple orchard. Larvae of *L. subjuncta* were collected at six sites in the Yakima River Valley, as well as near Mattawa, Washington and Milton-Freewater, Oregon. It is assumed that this species of moth is widely distributed in irrigated areas of the PNW. According to McCabe (1980) it occurs throughout much of North America, including Washington.

Lacanobia subjuncta uses apple and possibly other tree fruit species as a primary host, although it may also utilize other plant species in and around orchards. All of our records (Table 1) involve larvae collected on apple, pear, or plum trees, indicating likely feeding and development on those hosts. Collected larvae were able to finish development on apple, pear, or plum foliage and numerous larvae (several hundreds) were successfully reared in the laboratory from egg to adult on apple foliage. One larva was collected while feeding on an apple fruit, but it is likely that most larvae collected were feeding on foliage.

Previous host records and rearing records indicate broad polyphagy for *L. subjuncta*. This species has been reported on a wide variety of trees and shrubs including fruit of blueberry, cherry, and sour cherry (Phipps 1930, Prentice 1962, Rockburne & Lafontaine 1976, Godfrey 1972, Rings et al. 1992). Given its broad host range on woody plants, it is not surprising that it occurs on apple, pear, and



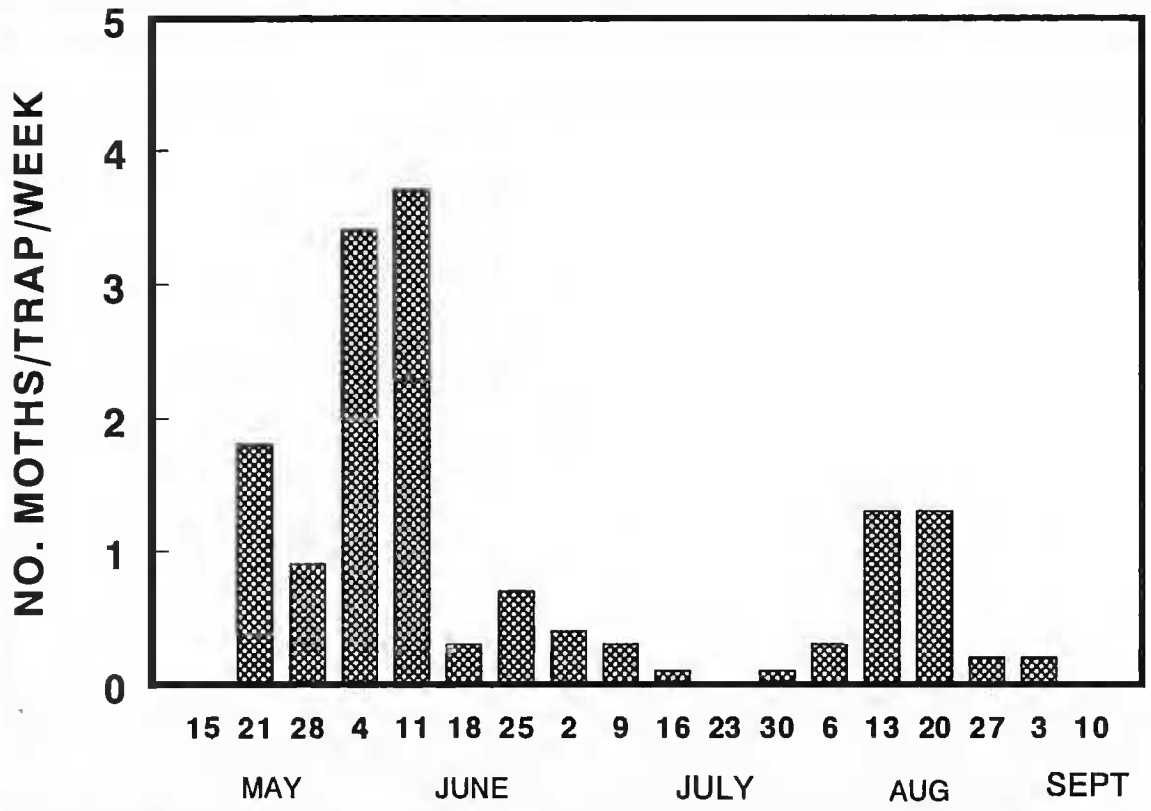


Figure 1. Seasonal pattern, as weekly trap captures, of *Lacanobia subjuncta* moths in Golden Delicious apple orchards near Parker, Yakima Co., Washington, May–September 1996. Numbers are calendar dates for beginnings of weeks. Data are pooled from two trapping experiments; molasses and jaggery solutions in McPhail traps (above) and molasses solution in bowl, Dome, McPhail, and Multipher traps (below).

Table 2. Development of *Lacanobia subjuncta* on foliage of weed species, Yakima County, Washington, 1996. $n = 25$.

Common name	% Pupation	% Adult emergence	Pupal weight (mg)
Dandelion	24	20	293.3 ± 8.4
Black Medic	16	0	
Sow Thistle	32	28	285.9 ± 17.1
Bindweed	36	28	319.1 ± 18.3
Pigweed	0	0	
Mallow	24	20	292.2 ± 27.6
Lambsquarters	4	0	

plum, although these plants have not been reported previously as hosts of *L. subjuncta*. Godfrey (1972) also reported several herbaceous plants (weeds and vegetables) as hosts. It also completed development on four common weed species found in local orchards; dandelion, sow thistle, mallow, and bindweed. Godfrey (1972) also listed dandelion as a host.

The possible pest status of *L. subjuncta*, as well as that of *O. hibisci*, *L. antennata*, and *A. pyramidoides*, on PNW tree fruits, will require additional study. However, recent reports of damage to fruit in organic apple orchards attributed to cutworms (Warner 1996) may have been caused by *L. subjuncta*. *Lacanobia subjuncta* adults were abundant in the Yakima River Valley, while no adults of *O. hibisci*, *L. antennata*, or *A. pyramidoides* were collected in traps baited with sweet materials or in intermittent light-trapping in apple orchards. Adults of the univoltine *O. hibisci* and *L. antennata* may fly early in the spring (Howell 1993) before our trapping tests were initiated in mid-May.

Lacanobia subjuncta appears to be bivoltine. Two distinct peaks in the numbers of adults captured in traps, first in late May into early June and again in August, match the presence of larvae on apple trees in late June through July and again in September through October. Two broods were also indicated by McCabe (1980) for this species, based on collection dates for 1100 museum specimens examined.

Large numbers of both sexes of this moth were captured in McPhail, Multipher, and Dome traps baited with solutions of molasses and McPhail traps baited with diluted jaggery. Molasses and the Multipher and Dome traps are generally available and could be used to monitor or sample *L. subjuncta* adults.

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Literature Cited

Covell, C. V. Jr. 1984. Field Guide to the Moths of Eastern North America. Peterson Field Guide. Houghton-Mifflin Co.

Crumb, S. E. 1956. The larvae of the Phalaenidae. USDA Tech. Bull. No. 1135. Washington, D.C.

Godfrey, G. L. 1972. A review and reclassification of larvae of the subfamily Hadeninae (Lepidoptera: Noctuidae) of America north of Mexico. USDA, ARS, Tech. Bull., 1450.

Howell, J. F. 1993. Green fruitworms and cutworms. *In* Beers, E. H., J. F. Brunner, M. J. Willett, & G. M. Warner (eds.). Orchard Pest Management. A Resource Book for the Pacific Northwest. Good Fruit Grower, Yakima, Washington.

Landolt, P. J. 1995. Attraction of *Mocis latipes* (Lepidoptera: Noctuidae) to sweet baits in traps. Fla. Entomol., 78: 523–530.

McCabe, T. L. 1980. A reclassification of the *Polia* complex for North America (Lepidoptera: Noctuidae). N. Y. St. Mus. Bull. No. 432, Albany.

Newell, W. 1936. Progress report on the Key West (Florida) fruit fly eradication project. J. Econ. Entomol., 29: 116–120.

Phipps, C. R. 1930. Blueberry and huckleberry insects. Maine Agric. Exp. Stat. Bull., 356: 107–221.

Prentice, R. M. 1962. Forest Lepidoptera of Canada. Nycteolidae, Noctuidae, Notodontidae, Liparidae. Can. Dept. For. Biol., Ottawa, Ontario., 128: 77–281.

Rings, R. W., E. H. Metzler, F. J. Arnold & D. H. Harris. 1992. The owlet moths of Ohio. Order Lepidoptera, Family Noctuidae. Ohio Biol. Survey Bull. (NS), 9: 1–184.

Rockburne E. W. & J. D. Lafontaine. 1976. The cutworm moths of Ontario and Quebec. Canada Dept. Agric. Res. Publ. 1593.

SAS Institute. 1985. SAS user's guide: statistics, version 5 ed. SAS Institute, Cary, NC.

Warner, G. 1996. Goodbye codling moth, but hello cutworms. Good Fruit Grower, 47: 17–18.

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